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ROCKET and LABORATORY STUDIES in ASTRONOMY

FINAL REPORT

NASA Grant NAG5-5122

March 1, 1997 to February 28, 2001

Prepared by

Paul D. Feldman, Principal Investigator
Center for Astrophysical Sciences
The Johns Hopkins University
Baltimore, Maryland 21218

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FINAL REPORT

This is the final report for NASA Grant NAG5-5122 and covers the period from March 1, 1997 to February 28, 2001. This grant was a continuation of a program in rocket and laboratory studies in ultraviolet astronomy that was supported by NASA grant NAG5-619. As of March 1, 2001, this program is continuing under grant NAG5-5315.

During the period of the grant, annual status reports have been submitted detailing the scientific achievements and current objectives of each report period. These will not be repeated here. Among the highlights of the program are four successful rocket launches including participation in the campaign to study comet Hale-Bopp in April 1997. We have continued our emphasis on long-slit spectroscopy of extended sources in the shorter wavelength far-ultraviolet, necessitating the development of evacuated telescope/spectrograph payloads. Finally, we also note the use of our ultraviolet calibration facilities in support of other sounding rocket investigators and for other space missions such as the Far Ultraviolet Spectroscopic Explorer. We include a list of the sounding rocket launches performed under NASA sponsorship during this period (Appendix A), a list of Ph.D. degrees awarded to students who worked in this program (Appendix B), and a summary bibliography of publications between 1997 and 2001 (Appendix C).

Appendix A

SUMMARY OF SOUNDING ROCKET LAUNCHES 1997-2001						
LAUNCH #	DAY	MONTH	YEAR	TARGET	VEHICLE	RANGE
36.156UG	5	April	1997	Comet Hale-Bopp	Black Brant- M70 (S-19)	White Sands
36.136UG	14	June	1999	M27	Black Brant- M70 (S-19)	White Sands
36.186UG	11	February	2000	NGC2023	Black Brant- M70 (S-19)	White Sands
36.198UG	9	February	2001	IC405	Black Brant- M70 (S-19)	White Sands

Appendix B

**STUDENTS TRAINED IN GRADUATE SPACE SCIENCE PROGRAMS
1997 - 2001**

ERIC B. BURGH

Ph.D. 2001

Dissertation: *Far-ultraviolet Studies of Dust Extinction and
Scattering*

Present Address: University of Wisconsin – Madison,
WI 53706

JASON B. McPHATE

Ph.D. 1998

Dissertation: *Carbon Monoxide in Comets*

Present Address: UC Berkeley, Berkeley, CA 94720

Appendix C

PUBLICATIONS 1997-2001

This list contains papers of research done entirely or partially under NASA grant NAG 5-5122.

P.F. Morrissey, P.D. Feldman, J.T. Clarke, B.C. Wolven, D.F. Strobel, S.T. Durrance, and J.T. Trauger, Simultaneous Spectroscopy and Imaging of the Jovian Aurora with the Hopkins Ultraviolet Telescope and the Hubble Space Telescope, *Astrophysical J.* **476**, 918-923 (1997).

S. R. McCandliss, J. B. McPhate, and P. D. Feldman, Narcissistic ghosts in Rowland gratings mounted with $\beta = 0^\circ$: a cautionary note, *Applied Optics* **37**, 5070-5074 (1998).

S. R. McCandliss, P. D. Feldman, J. B. McPhate, E. B. Burgh, C. Pankratz, R. Pelton, S. Nikzad, O. Siegmund, & J. Vallergha, Current and Planned FUV Technology Development at the Johns Hopkins University, in *Ultraviolet-Optical Space Astronomy Beyond HST*, eds. J. A. Morse, J. M. Shull, & A. L. Kinney, San Francisco: ASP, p. 437 (1999).

P. D. Feldman, Ultraviolet observations of comet Hale-Bopp, *Earth, Moon and Planets* **79**, 145-160 (1999).

J. B. McPhate, P. D. Feldman, S. R. McCandliss, and E. B. Burgh, Rocket-borne long-slit ultraviolet spectroscopy of comet Hale-Bopp, *Astrophysical J.* **521**, 920-927 (1999).

E. B. Burgh, S. R. McCandliss, B-G Andersson, and P. D. Feldman, On the Correlation between CO Absorption and Far-Ultraviolet Nonlinear Extinction toward Galactic OB Stars, *Astrophysical J.* **541**, 250-256 (2000).

S. R. McCandliss, E. B. Burgh, and P. D. Feldman, Flyable windowless calibration lamps for far-UV spectroscopy, *SPIE* **4139**, *Instrumentation for UV/EUV Astronomy and Solar Missions*, 70-79 (2000).

S. R. McCandliss, E. B. Burgh, P. D. Feldman, Ultraviolet groove efficiency of a holographic grating: implications for a dual-order spectrograph, *Applied Optics* **40**, 2626-2632 (2001).

E. B. Burgh, S. R. McCandliss, R. Pelton, K. France, and P. D. Feldman, Windowless vacuum ultraviolet collimator, *SPIE* **4498**, *UV/EUV and Visible Space Instrumentation for Astronomy and Solar Physics*, (2001).

PAPERS PRESENTED

P. D. Feldman, Recent Observations of Comets from Space, Colloquium, Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, April 18, 1997.

P. D. Feldman, Ultraviolet observations of comet Hale-Bopp, Invited paper, 23rd General Assembly, International Astronomical Union, Kyoto, Japan, August 18-30, 1997.

J. B. McPhate, S. R. McCandliss, P. D. Feldman, E. B. Burgh, and R. Pelton, Rocket borne long-slit UV spectroscopy of comet Hale-Bopp, presented at the 1997 DPS Meeting, July 28-August 1, 1997, Cambridge, MA, *Bull. Amer. Astron. Soc.* **29**, 1051 (1997).

P. D. Feldman, Ultraviolet Observations of Comet Hale-Bopp, invited paper presented at the First International Conference on Comet Hale-Bopp, Tenerife, Spain, February 2-5, 1998.

J. B. McPhate, S. R. McCandliss, P. D. Feldman and E. B. Burgh, Rocket-Borne Long-Slit Ultraviolet Spectroscopy of Comet Hale-Bopp, presented at the First International Conference on Comet Hale-Bopp, Tenerife, Spain, February 2-5, 1998.

E. B. Burgh, S. R. McCandliss, P. D. Feldman Far-Ultraviolet and Optical Long-Slit Spectroscopy of the Dumbbell Nebula (M 27), American Astronomical Society Meeting, Atlanta, GA, January 2000, *Bull. Amer. Astron. Soc.* **31**, abstract 110.11 (1999).

E. B. Burgh, S. R. McCandliss, & P. D. Feldman, Rocket Observations of Far-Ultraviolet Dust Scattering in NGC 2023, American Astronomical Society Meeting, San Diego, CA, January 2001, *Bull. Amer. Astron. Soc.* **32**, 1446, 42.06 (2000).

S. R. McCandliss, K. R. Sembach, E. B. Burgh, D. J. Sahnou, & FUSE Team, Hot Molecular Hydrogen in M27 Observed by FUSE, American Astronomical Society Meeting, San Diego, CA, January 2001, *Bull. Amer. Astron. Soc.* **32**, 1399, 06.11 (2000).